NIDIS ANNUAL REPORT

2020

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Cover image: A brush fire dubbed the Johnson Fire began with a vehicle fire and spread to over 200 acres. Lake Hughes, California; Aug. 28, 2020. Credit: Jeffrey Crockard

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LETTER FROM DIRECTOR

We are pleased to share with you the 2020 Annual Report of the National Integrated Drought Information System (NIDIS).

The year 2020 was exceptionally difficult for people worldwide, as the COVID-19 pandemic ravaged the globe and altered almost every facet of daily life. At NIDIS, the past year called on us to stay connected like never before. With the strength of our long-standing, core partners alongside us, we collaborated seamlessly in a virtual environment to deliver timely and relevant drought information at a time in which communities, institutions, and decision makers faced unprecedented challenges.

Not only was 2020 a significant drought year for the United States, it also brought record-breaking heat and devastating wildfires. The year began with very little drought across the United States, limited to the Northwest, Four Corners, and south Texas. By the end of 2020, intense drought conditions existed from the Great Plains to the West Coast, and over 40% of the country was in drought. Unfortunately, the outlook for early 2021 only indicates further drought expansion, particularly across the West.

Each year, NIDIS makes its impact through support for drought monitoring, prediction, planning, communication, and research. In 2020, those key components of our work were vital to our success. We made critical investments in our National Drought and Wildfire Nexus (NDAWN) partnership to support tool development, research, and communications that directly benefit wildland fire managers. We completed a strategy for the development of a National Coordinated Soil Moisture Monitoring Network, capitalizing on the transformative potential of soil moisture data for a wide range of early warning applications across sectors of the economy. With our Federal, tribal, and other partners, NIDIS jointly released the *NIDIS Tribal Drought Engagement Strategy* to wide praise from tribal communities across the Midwest and Missouri River Basin. And in December, we were proud to convene researchers and decision makers to develop a shared understanding of flash drought and to identify research and tools needed to improve flash drought early warning.

Inside this report, you will see how we are advancing these and other national initiatives, as well as implementing on-the-ground activities across our 9 regional Drought Early Warning Systems.

Sincerely,

Veva Deheza
Executive Director
NOAA NIDIS

ABOUT NIDIS

In 2006, the National Integrated Drought Information System (NIDIS) Act (P.L. 109-430) was signed into law, calling for the development of a national drought early warning system to collect information on the key indicators of drought in order to provide timely and relevant forecasts and assessments of drought to the American people.

Congress called on NIDIS to coordinate federal drought research, and to build upon existing federal, tribal, state, and local forecasting and assessment partnerships. NIDIS is led by the Climate Program Office of the National Oceanic and Atmospheric Administration (NOAA). The Public Law reauthorizing NIDIS in 2014 (P.L.113-86) further identifies the following goal of NIDIS, to "continue ongoing research and monitoring activities related to drought, including research activities relating to length, severity, and impacts of drought and the role of extreme weather events and climate variability in drought."

NIDIS was again reauthorized in 2019 (P.L. 115-423), calling on NIDIS to advance several additional priorities:

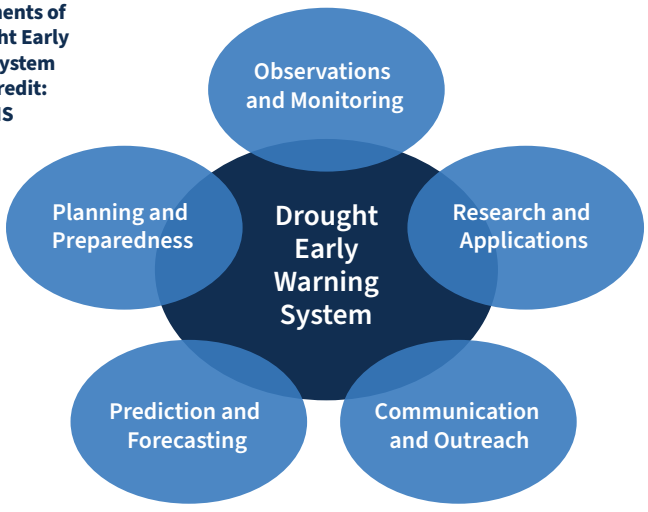
- Provide timely data, information, and products that reflect watershed differences in drought conditions
- Utilize existing forecasting and assessment programs and partnerships, including forecast communication coordinators and cooperative institutes, and improvements in seasonal and subseasonal precipitation and temperature and low flow water prediction
- Engage with the private sector to improve drought monitoring, forecast, and communication, if such partnerships are appropriate, cost-effective, and beneficial to the public and certain decision-makers
- Utilize and support monitoring by citizen scientists, including by developing best practices to facilitate maximum integration of data
- Develop a strategy for a national coordinated soil moisture monitoring network

NIDIS's goal is to improve the nation's capacity to manage drought-related risks by providing the best available information and tools to assess the potential impacts of drought, and to prepare for and mitigate the effects of drought. Toward that end, NIDIS seeks to create a Drought Early Warning System (DEWS) for all regions of the nation.

NIDIS Mission

NIDIS's mission is to improve the nation's capacity to proactively manage drought-related risks, by providing those affected with the best available information and resources to assess the potential for drought and to better prepare for, mitigate, and respond to the effects of drought.

Developing a nationally-consistent DEWS requires more than a one-size-fits-all solution. Drought in Maine looks different from drought in New Mexico. When seeking indicators of drought, a place that depends on snowpack for its annual water supply must monitor different factors compared to a place where liquid precipitation



► Components of the Drought Early Warning System (DEWS). Credit: NOAA NIDIS

▲ Map of regional Drought Early Warning Systems (DEWS). Credit: NOAA NIDIS, Fiona Martin

determines the hydrology. Local economies, resources, and values influence how government, business, and the public respond to drought prediction, monitoring, and impacts. NIDIS's approach to building the foundation of a national DEWS has been to develop regional DEWS, where networks of researchers, academics, resource managers, policymakers, and other stakeholders share information and actions that help communities cope with drought.

WHAT IS A REGIONAL DEWS?

A regional DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local, and academic partners in order to make climate and drought science and impact data readily available, easily understandable, and usable for decision makers. A regional DEWS also improves the capacity of stakeholders and economic sectors to better monitor, forecast, plan for, and cope with the impacts of drought at all spatial and time scales. □

Dry river in Arizona.
Credit: YaromirM

RESEARCH & RESOURCES

This section features just some of the NIDIS research projects completed in 2019 as well as several decision-support resources that are in development or available now. Check out the section on the Drought Early Warning Systems (DEWS) to learn about many more NIDIS research projects and tools.

WILDFIRES

Drought, especially when combined with warming temperatures, can result in decreased snowpack and streamflow, increased evaporative demand, dry soils, and large-scale tree deaths, which results in increased potential for large wildfires. This scenario played out in the worst way in 2020, as extreme heat across the West over the summer, along with persistent drought, led to an explosion in large wildfires.

Fire fighting helicopter carries water bucket to extinguish a forest fire. Credit: Toa55

NIDIS is taking a multi-pronged approach to helping the U.S. prepare for and respond to drought-related wildfires. The centerpiece of this approach is the NIDIS Drought and Wildfire Nexus (NDAWN), a partnership with the Western Regional Climate Center (WRCC) at the Desert Research Institute (DRI), in consultation with the fire management community. The primary goals of NDAWN are to improve the use of drought information by wildland fire management, air quality managers, fire meteorologists, and fire behavior analysts, and to enhance and develop products to improve firefighter safety, public health and safety, fuel treatment effectiveness pre- and post-fire, and meet overall land management objectives. Broader planning and preparedness topics, including preventing economic and infrastructure losses, are addressed in NDAWN as well.

NDAWN is both a strategy and a network. As a strategy it defines the needs and challenges of fire managers to effectively utilize drought information and aims to meet those needs and to establish a robust drought and wildland fire decision-support information network. This strategy presents a framework to guide how NIDIS investment could benefit both wildland firefighters and public health and safety in fire-prone areas of the United States. NDAWN also functions as a network at multiple scales, from sub-regional to national. This multi-tiered approach of direct engagement with sub-regional stakeholders, regional entities such as the National Interagency Fire Center (NIFC) Predictive Services and the Geographic Area Coordination Centers (GACC), national entities such as the National Wildfire Coordinating Group, and the National Cohesive Wildland Fire Strategy enables NIDIS and its partners to better understand drought impacts for on-the-ground fire management and identify how drought impacts could be mitigated.

The outputs of NDAWN will include tools, research, and communications. Just a few examples of these outputs are highlighted below.

TOOL DEVELOPMENT

Forecasts of National Fire Danger Rating System Fire Danger Indices

This ongoing project, led by researchers with UC-Merced, will develop an automated system for subseasonal forecasts for fire danger indices and relative fire risk metrics that are directly applicable to fire business decision makers and support early warning efforts in wildland fire operations. It is envisioned that these forecasts will be incorporated into the Climate Toolbox and Climate

Aerial view of destruction caused by the Almeda Wildfire in Phoenix, Oregon. Credit: arboursabroad

Engine and complement existing outlooks developed by Predictive Services and other outlets.

Organic Soil Moisture Monitoring in Coastal North Carolina: Assisting Coastal Zone Fire Risk Monitoring and Management

The State Climate Office of North Carolina, with funding from NIDIS and support from Carolinas Integrated Sciences and Assessments (a NOAA RISA team), established a system of organic soil moisture monitoring stations at select locations in eastern North Carolina. Real-time information from this network will address needs regarding coastal zone fire risk. A *summary document* was developed in 2020.

RESEARCH

Projected Changes in Reference Evapotranspiration in California and Nevada: Implications for Drought and Wildland Fire Danger

Research funded by NIDIS and the California-Nevada Applications Program (CNAP) (a NOAA RISA team), shows that climate change projections point to increases in evaporative demand, fire danger, and drought in California and Nevada. The research, published in *Earth's Future* in 2020, also shows that multi-year droughts are projected to increase. CNAP, with NIDIS support, continues to engage with fire managers and their use of the Evaporative Demand Drought Index (EDDI) to monitor the wildfire threat. For example, Predictive Services is now using EDDI in the weekly updated national weather and fuels briefings.

Monitoring Debris Flow and Flood Activity Following Wildfire: How Do Drought and Vegetation Recovery Influence Post-Wildfire Hazards?

While there is a strong connection between drought and wildfire in the western U.S., how drought influences the post-wildfire environment is less well-understood. This ongoing NIDIS-funded research by the WRCC and the University of Arizona, as described in this *summary document*, will identify relevant drought and vegetation recovery metrics that can be monitored remotely using data derived from satellites (e.g., Climate Engine), to inform how post-fire hazards change with time.

COMMUNICATION

Enhancing the Red Flag Warning Matrix

CNAP, NIDIS, NWS, and fire personnel have conducted

The LNU Lightning Complex Fires burn through a neighborhood forcing residents to evacuate. Fairfield, California; August 19, 2020. Credit: Trevor Bexon

an assessment of the Red Flag Warning (RFW) definition, inputs, usefulness, usability, and impact. This assessment has led to an ongoing project, described in this *fact sheet*, with the NWS to develop a prototype RFW decision matrix, which will be initially vetted in CA-NV with NIDIS support. The final product will serve fire management, emergency managers, and the public.

2020 US Fire Outlook

Most of the Western United States was experiencing drought or dryness going into summer 2020, with the potential for an especially challenging wildland fire year (which ultimately occurred). NIDIS invited the National Interagency Fire Center (NIFC) to provide fire outlooks on California/Nevada and Pacific Northwest webinars and then developed the *2020 U.S. Fire Season Outlook* from these presentations to communicate the threat to stakeholders and the public. □

▲ **Red Flag Warnings Project**

▲**Post-Wildfire Project:** ***Drought Influences on Post-Wildfire Flooding and Debris Flow Hazard*****. Credit: NOAA NIDIS**

Drought-parched, recently planted desert cotton field. Credit: Jerry Horbert

PROGRESS TOWARDS A NATIONAL COORDINATED SOIL MOISTURE MONITORING NETWORK

The National Coordinated Soil Moisture Monitoring Network (NCSMMN), a multi-agency initiative led by NIDIS, is continuing to lay the foundation for high-resolution, real-time gridded national soil moisture products that leverage data from in situ networks, satellite platforms, and land surface models to support a wide range of public information needs.

Important successes for the NCSMMN in the past year include:

- Coordinated **soil moisture network expansions** in the Upper Missouri River Basin and in the Southeastern U.S., both areas that were previously underrepresented
- Development of **proof-of-concept gridded national soil moisture maps** blending in situ, satellite, and modeled data
- Active **stakeholder engagement and interaction** through annual National Soil Moisture Workshops and other venues

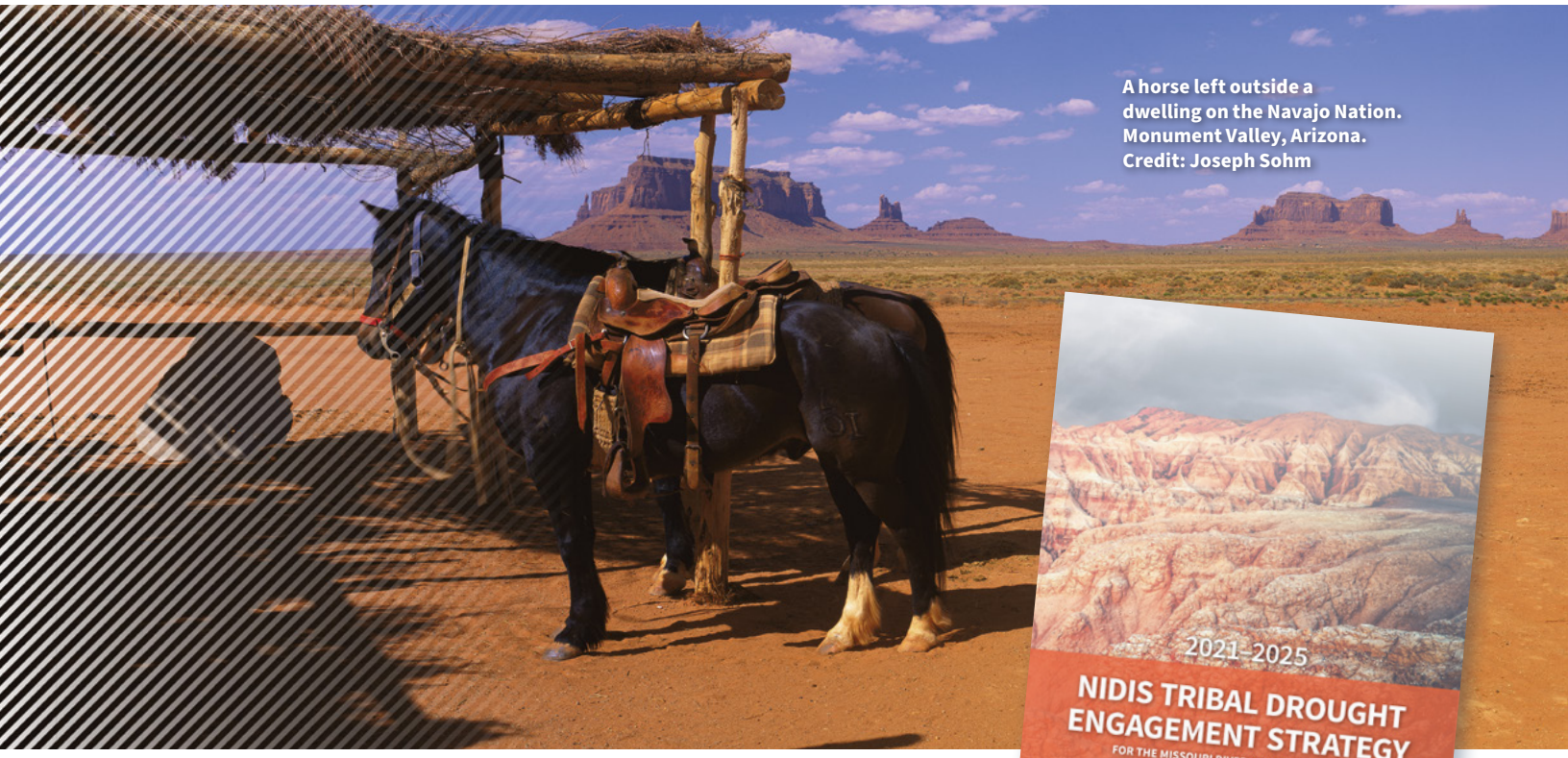
In 2020, the U.S. Army Corps of Engineers funded installation of the first 3 pilot stations of a planned *500+ soil*

▲ **Cross-section of soil. Credit: Elena Arkadova**

moisture and snowpack monitoring stations that will be part of five state mesonets in the Upper Missouri River Basin (North Dakota, South Dakota, Montana, Wyoming, and Nebraska). The project also includes soil characterization at each station to be performed by the USDA Natural Resources Conservation Service. Meanwhile, in the Southeastern U.S., the states of Alabama, Florida, and Georgia were all awarded grants in 2020 from the NOAA Weather Program Office to support coordinated *soil moisture monitoring build-out and applications development*.

As a key component in the development of gridded soil moisture maps, NIDIS funded a study through NOAA's Climate Program Office Modeling, Analysis, Predictions, and Projections (MAPP) Program to evaluate in situ soil moisture observations from 1,200+ stations across multiple federal and state mesonets. This was the first study to complete an in situ data validation effort at this scale in the United States. The study by Ford et al., published in the *Journal of Hydrometeorology*, employed a triple collocation approach to evaluate the fidelity of in situ soil moisture observations across the contiguous United States. It was found that 90% of the 1,233 stations evaluated exhibited high spatial consistency with satellite remote sensing and land surface model soil moisture datasets. In addition, in situ error did not significantly vary by climate, soil type, or sensor technology, but instead, the stations with high error were affected by land cover and station factors that are more difficult to identify.

A notable outreach activity for the NCSMMN in 2020 was the "Virtual National Soil Moisture Workshop: A Vision for the Next Decade of Soil Moisture Monitoring" held on August 12 and 13, 2020, with 180 participants. The popular annual workshop, sponsored by USDA, NIDIS, and NOAA, is designed to provide a unique opportunity for leaders in soil moisture research, development, and applications to come together in an interactive workshop format to exchange ideas and enhance collaborations. □



A horse left outside a dwelling on the Navajo Nation. Monument Valley, Arizona. Credit: Joseph Sohm

TRIBAL DROUGHT ENGAGEMENT STRATEGY

Indigenous experiences and perspectives of drought vary greatly across the United States. By integrating these diverse perspectives into NIDIS' work, we will be able to foster a culturally appropriate engagement practice and work with tribal nations as equal partners in responding to drought.

NIDIS released its inaugural *Tribal Drought Engagement Strategy* in 2020, which presents guiding principles of tribal engagement, as well as key outcomes and tribal engagement activities for NIDIS and partners to implement in 2021 and beyond. This Strategy was developed by engaging with tribal nations within the Missouri River Basin and Midwest Drought Early Warning Systems (DEWS), but most activities are applicable to tribal nations across the country.

The Strategy, developed in collaboration with the Masters of the Environment Program at University of Colorado-Boulder, included a year of consultations with tribal resource managers across the two regions. These consultations helped identify critical needs and the actions that could be taken to address them.

▲ **The *2021–2015 NIDIS Tribal Drought Engagement Strategy*. Credit: NOAA NIDIS**

Two types of information are encompassed in the Strategy. The first are a set of Guiding Principles of Engagement that capture important approaches that NIDIS wants to embody in partnerships with tribal nations. Following these principles are Key Outcomes and Activities that are organized around the five components of a DEWS (interdisciplinary research and applications; predictions and forecasting; observations and monitoring; planning and

98th Gallup Intertribal Indian Ceremonial, New Mexico. August 10, 2019. Credit: Joseph Sohm

preparedness; and communications and outreach). The Strategy also provides a framework for integrating indigenous perspectives into the DEWS. Ultimately, implementation of the Strategy will lead to improved drought monitoring, forecasting, and resilience for tribal nations.

NIDIS also held a webinar in 2020 that provides an overview of key learnings from a Tribal Drought Engagement Project. The Webinar included key engagement strategies and priorities moving forward and was attended by almost 200 people. □

▲ Native American men at the 98th Gallup Intertribal Indian Ceremonial, New Mexico. August 10, 2019. Credit: Joseph Sohm

◄ Navajo children playing in the sand in Monument Valley, Arizona. April 19, 2014. Credit: Meunierd

▲ **Agricultural field on which, due to drought, the green leaves of sugar beets have wilted. Credit: rsooll**

FLASH DROUGHT

Clear conceptualization of flash drought is important to both the research and end user/practitioner communities, as there are differing understandings and confusion on what flash drought is and how it differs from other droughts. To address this need, NIDIS held the Virtual Flash Drought Workshop in December 2020 that convened researchers and practitioners to begin developing a shared understanding/definition of flash drought, and to identify research and tools needed to improve flash drought early warning.

Over three days of meetings there was broad participation (around 120 attendees each day) and a robust sharing of perspectives through breakout sessions, plenary discussion, and an active chat box. There was agreement that a general framework to define flash drought is necessary. However, any framework requires flexibility in developing specific numerical attributes, indices, and thresholds, given the complexity of the phenomenon and what questions are being asked. Applying this framework will also clarify how flash drought is different from conventional drought.

With a goal of striving for agreement on the basic set of characteristics for flash drought, there was general consensus among workshop attendees that the key feature of flash drought is rapid onset/rapid intensification of drought conditions. There is a need for some standardization on how "rapid" is rapid onset/intensification (e.g., rate of change, thresholds). Discussion also focused on the difference between rapid onset and rapid intensification and whether the term "flash drought" should be used for both; i.e., for a rapidly developing event that occurs both during non-drought conditions and one that occurs within the context of a longer-term, slower-evolving drought. It was stressed that the relevance of characterizing flash drought to decision makers and drought managers is that any such rapid change requires a rapid management response.

The workshop participants identified seasonality,

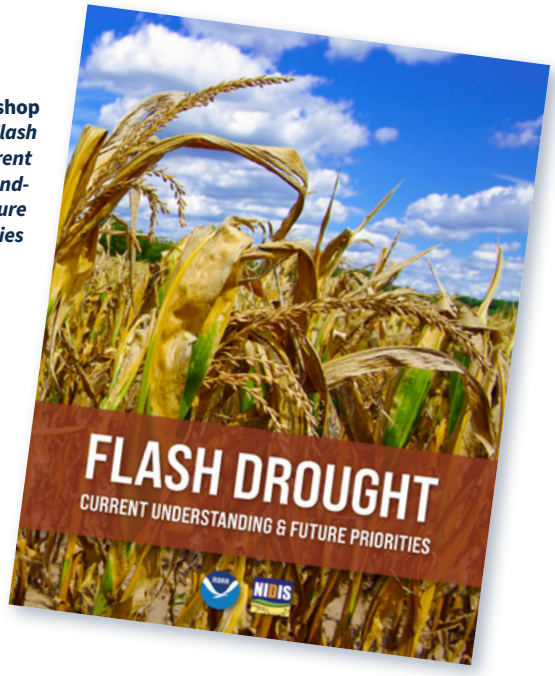
▲ **Lawns can dry out almost overnight during a flash drought. Credit: Suzanne Tucker**

regionality, and impacts as key attributes for characterizing flash drought. However, impacts, by themselves, are not the best candidates to serve as leading indicators of flash drought, given the need to provide early warning of flash drought before impacts become evident. It is also important to determine the audience, particularly the practitioner sector, for whom we are defining flash drought because different audiences (researchers, practitioners, others) may require different definitions.

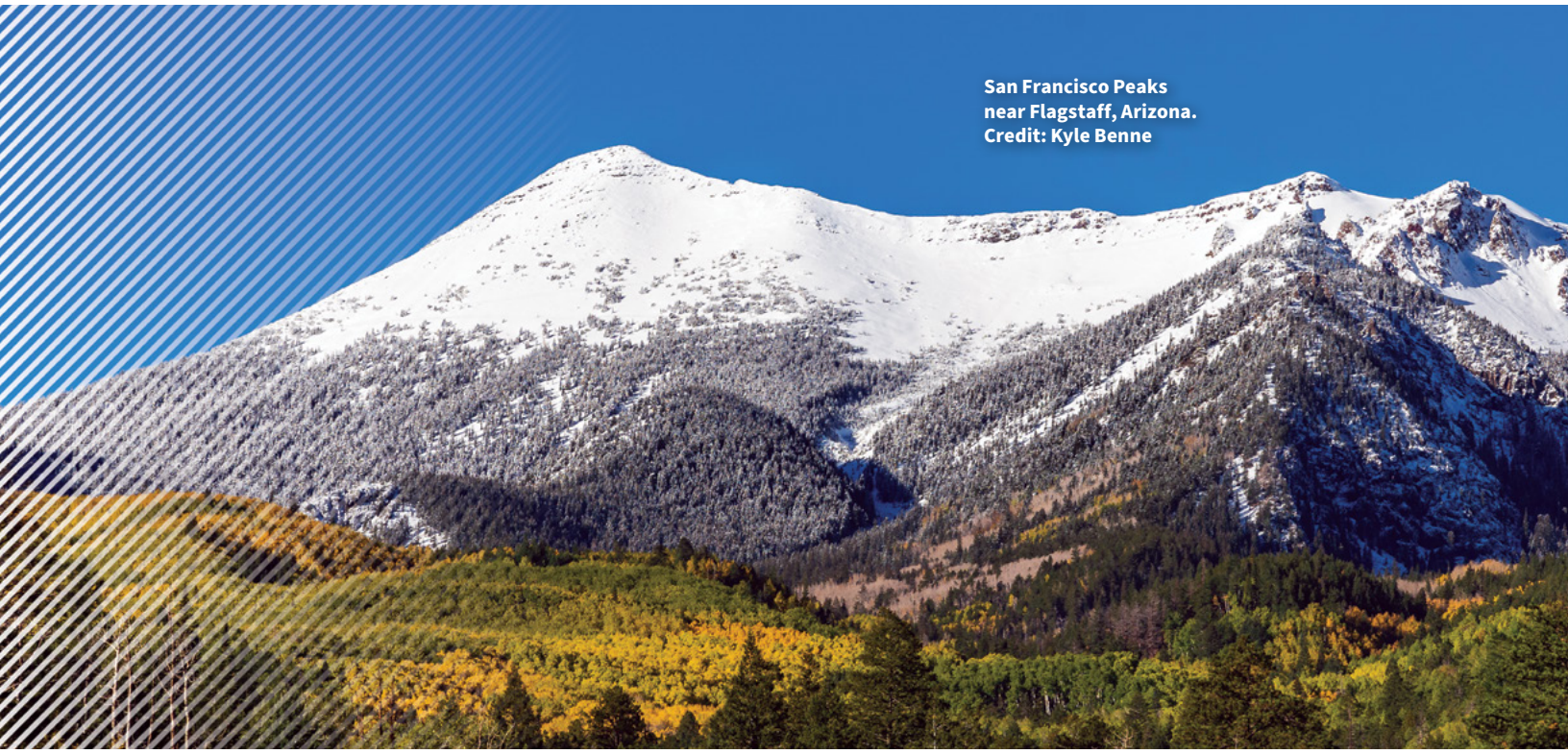
Workshop attendees conveyed that there are many different indicators and indices that can be considered when studying flash drought. However, there is a need for an integrated set of different indicators, given the complexity of the phenomenon and its cascading impacts.

Research should address key indicators that are specific to flash drought. It's also important to clarify in what circumstances (regions, seasons, etc.) each indicator is of value.

A comprehensive workshop report, detailing workshop outcomes including prioritized research and tool development opportunities, was published in 2021 and will be used by NIDIS to develop a flash drought action agenda. □



► **Workshop report: *Flash Drought: Current Understanding and Future Priorities***



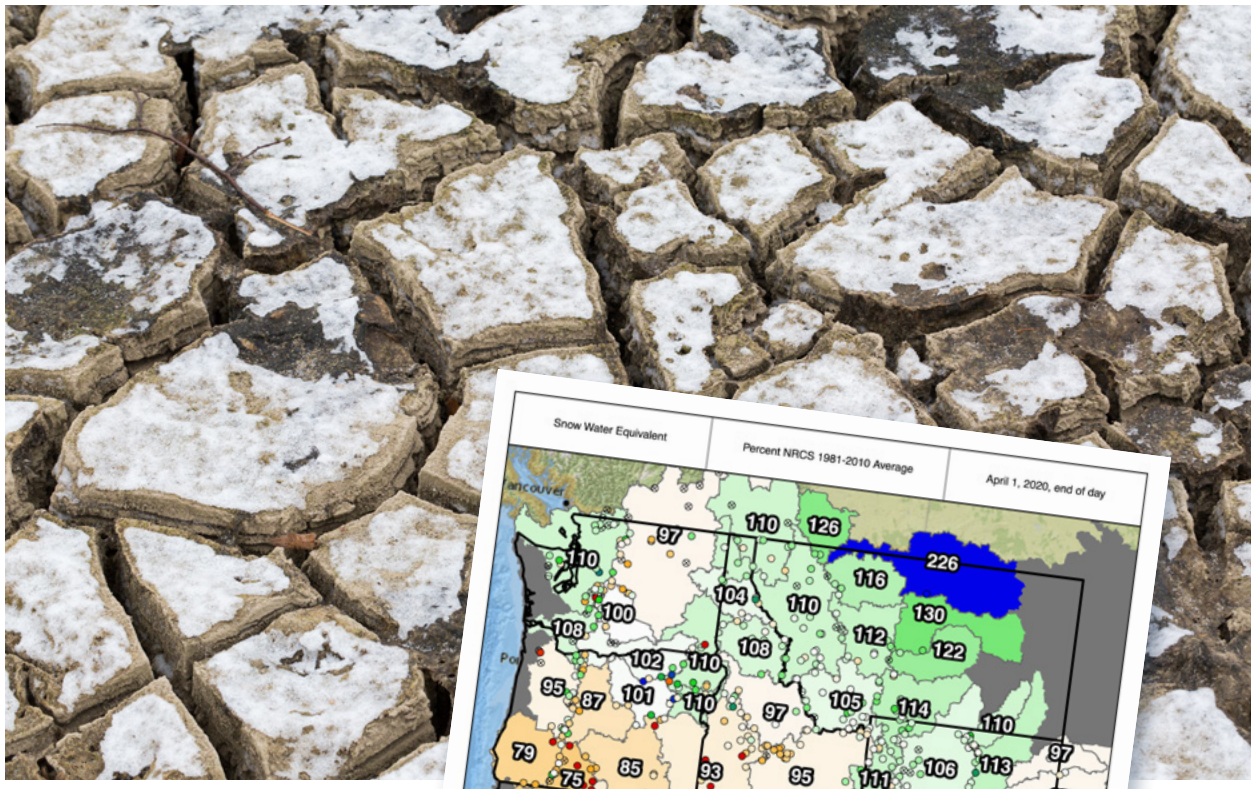
San Francisco Peaks near Flagstaff, Arizona. Credit: Kyle Benne

SNOW DROUGHT

Snowpack is a vital natural reservoir, particularly in western states, where it provides an important source of water to humans and ecosystems alike. When snow drought does occur, the impacts are widespread, affecting ecosystems, reservoir levels and operations, water resource management, tourism, and outdoor recreation.

NIDIS issued nine snow drought updates in 2020. The updates, issued in partnership with the Western Regional Climate Center and Desert Research Institute, are posted on drought.gov every four weeks from December through June and provide the latest snow drought conditions throughout the West and Alaska. Tracking snow drought was particularly important in 2020, as the 2019-2020 snow season ended with a number of regions in snow drought, including part of the Lower Colorado River Basin in Arizona and New Mexico, the Sierra Nevada, the Great Basin, and parts of the Cascade Range. The seeds of the 2020 drought and accompanying wildfires were planted with this snow drought.

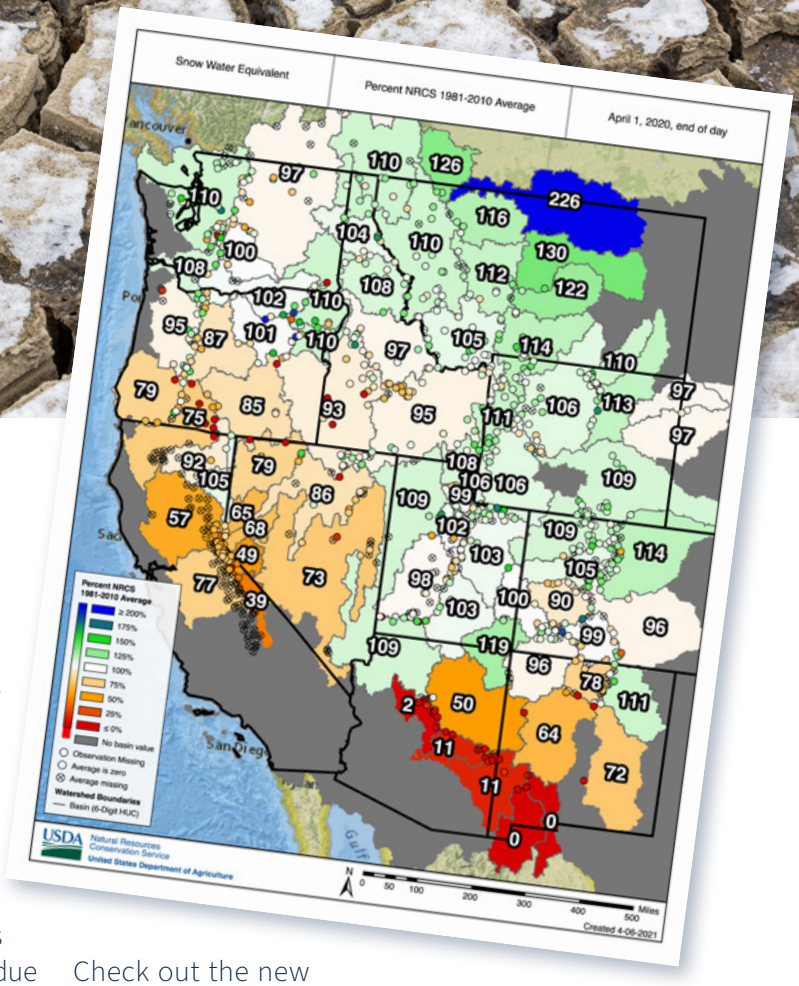
In addition to providing the latest conditions, NIDIS has also funded a number of research projects on snow drought. NIDIS-supported research through NOAA's Climate Program Office MAPP program, and published in *Proceedings of the National Academy of Sciences*, developed a new framework for characterizing snow droughts around the world. Using a framework to analyze conditions from 1980 to 2018, researchers from the University of California, Irvine found a 28% increase in the length of intensified snow-water deficits in the western United States during the second half of the study period. Analysis using the new framework shows prolonged snow droughts in California, Oregon, Washington and other Western states, and, to a lesser extent, Eastern Russia and



Europe over the nearly four-decade term studied.

▲ **Dry, cracked soil with a sparse layer of snow. Credit: Chris Redan**

Snowpack is currently used in streamflow models and drought predictions because there is a clear and well-understood relationship between winter snowpack and spring runoff. But the current warming trend will likely affect both snow amount and snow elevation in the coming decades. How will increasing temperatures and declining snowpack affect the relationship between snow and runoff? Will longer distances between the melting snow and the streams mean an unpredictable volume of water can be lost due to evaporation? To address changing conditions in a warming world, NIDIS is funding a project through NOAA's Climate Program Office MAPP program, and led by the Cooperative Institute for Research In Environmental Sciences (CIRES) at the University of Colorado-Boulder, that will develop new techniques for drought prediction that do not rely purely on snow-based methods, harnessing alternative techniques to improve scientists' ability to predict and respond to drought. A key innovation will be the use of Machine Learning techniques to find ways to improve current and future drought prediction.



Check out the new *drought.gov* for the latest snow drought updates and maps, as well as a Research and Learn section describing the importance of snowpacks, impacts of snow drought, and what snow drought may look like in the future. □

▲ **USDA Natural Resources Conservation Service (NRCS) snow water equivalent (SWE) basin values over the western U.S. for April 1, 2020.**

Drying lake. Credit: Piyaset. (*Inset*) Intro slide from Impact of Anthropogenic Warming on an Emerging North American Megadrought.

CLIMATE-DRIVEN MEGADROUGHT

A study published in 2020 the journal *Science* says a megadrought as bad or worse than anything even from known prehistory is very likely in progress, and warming climate is playing a key role.

The study, led by Columbia University, was based on modern weather observations, 1,200 years of tree-ring data, and dozens of climate models. Co-authored by researchers from CIRES at the University of Colorado Boulder and others, the study covers an area stretching across nine U.S. states from Oregon and Montana down through California and New Mexico, and part of northern Mexico.

NIDIS hosted two webinars in 2020 focusing on this megadrought. "Impact of Anthropogenic Warming on an Emerging North American Megadrought" explored the severe and persistent 21st-century drought in southwestern North America, compared it to medieval megadroughts, and discussed the role of anthropogenic climate change. "Coping With Megadrought in the Colorado River Basin" discussed how water managers are working on ways to adapt to a long term dry pattern on the Colorado River that looks increasingly like one of the region's millennial megadroughts. Over 1,000 people registered for the Emerging North American Megadrought webinar and over 622 for the Megadrought in the Colorado River Basin webinar.

A third NIDS-hosted webinar focused on a potential megadrought in Texas. A study, published in *Earth's Future*, found that climate models are robust in projecting drying of summer season soil moisture and decreasing reservoir supplies for both the eastern and western portions of Texas during the 21st century. Further, projections indicate drier conditions during the latter half of the 21st century than even the most arid centuries of the last 1,000 years that included megadrought. The study was conducted by members of the Texas Water Research Network, a water research hub at the University of Texas Environmental Science Institute, and led by the Office of the Texas State Climatologist. All three webinars can be viewed on the NIDIS YouTube channel. □

Rafters on Clear Creek Canyon whitewater in Golden, Colorado. By Jim Lambert

DROUGHT & OUTDOOR RECREATION

Outdoor recreation is a major contributor to the nation's economy, but the future viability of many businesses—particularly small businesses—in the industry is threatened by drought vulnerabilities and projected increases in drought severity and frequency in the western United States.

NIDIS partnered with the University of Colorado's Masters of the Environment Graduate Program to research drought information needs of the outdoor recreation industry in the Intermountain West Drought Early Warning System (Arizona, Colorado, New Mexico, Utah, Wyoming), with the goal of addressing information needs and strengthening the industry's drought resilience. While the project focused on the Rocky Mountain states, much of the information presented can apply to other regions.

The resulting research report, *Drought and Outdoor Recreation: Impacts, Adaptation Strategies, and Information Gaps in the Intermountain West*, was published in 2020. The report presents research methods and findings, including detailed information for six key subsectors: ski resorts, snow-based recreation, lake-based recreation, fishing, rafting, and retail

Due to drought, the length of the outdoor recreation season is becoming shorter and shorter, significantly reducing business revenues. Reduced snowpack is limiting the length of the ski or snow-based seasons and low flows limit the length of the riversport season as well as reservoir levels needed for lake-based recreation. In the case of the fishing subsector, extreme low flows and high temperatures are also harming fish species essential to anglers.

Wildfires, fueled by hot and dry conditions, are also having direct and indirect impacts on outdoor recreation businesses. In some cases, fires directly affect the regions

◄ Woman skiing downhill. Credit: Wlad Go

► Fly fisherman. Credit: Cindy Creighton

◄ Woman walking a dog on a hiking path in Mountain View Park near Phoenix, Arizona. Credit: Susan Schmitz

where businesses operate and may prevent access for recreation or result in National Forest closures. In other cases, the public's perception of regional wildfires drives customers to other areas.

Diversification, such as ski resorts adding summer activities or expanding across multiple locations, is a common adaptation strategy for outdoor recreation businesses. But in most cases, diversification requires additional capital and resources; thus, smaller businesses often struggle to diversify their activities offered or areas of operation.

A clear theme that emerged in the research was that drought creates significant mental health challenges for business owners. As the viability of a business is threatened by drought, business owners are forced to work harder, make riskier choices, and generally expose themselves to severe financial consequences in order to stay afloat. Particularly distressed owners reported refinancing their homes for extra money, renting storage units to hold overstock, and generally losing sleep. Ultimately, this is creating unquantified economic and public health impacts which could be areas of future study.

Key information needed by the industry to plan effectively for drought is more accurate long-range (subseasonal to seasonal to annual) forecasts.These are critical for business decisions, including hiring, planning, retail procurement, and drought mitigation investments, such as snowmaking.

NIDIS is also funding a project to help the ski industry with better climate data. The ongoing research, led by the Colorado State University-based Colorado Climate Center, has found that ski areas managers often lack the tools and information to integrate the latest and most local climate data into operations and in planning for a successful future. Final results are expected in 2021.

Lastly, NIDIS has developed a *Recreation and Tourism Sector* page on the new U.S. Drought Portal. The maps in this section display U.S. recreation and tourism attractions currently in drought, including ski areas, national parks, and reservoirs. Additionally, there is information on drought impacts on the sector as well as links to resources. □

▲ **Cracked ground seen through a magnifying glass. Credit: Francesco Scatena**

NIDIS LAUNCHES 16 DROUGHT RESEARCH PROJECTS IN 2020

COPING WITH DROUGHT GRANT PROJECTS

NIDIS announced five new Coping with Drought projects in 2020 through a multi-program collaboration that aims to improve our understanding and use of drought indicators, thresholds and triggers, and drought impact reporting to inform decision-making to prepare for and respond to drought. The competitively selected projects total $2,776,805.

For the FY20 Coping with Drought competition, NIDIS encouraged applicants to focus on industry and economic sectors beyond agriculture (e.g., tourism and recreation, navigation, water utilities, manufacturing, ecosystem services, and public health). The portfolio of projects selected includes lead institutions in Colorado, Washington, Idaho, California, and Nebraska. These are led by federal partners, non-federal universities, nonprofits, nongovernmental institutions, and small businesses. Applied research will focus on emerging issues such as ecological drought, drought impacts to tourism and recreation, public health, water storage and conveyance systems, and the complex connections between drought indicators and impacts.

The 5 new projects funded by NIDIS Coping with Drought are:

- Visualizing ecological drought impacts, vulnerabilities, and drivers to inform decision-making
- Improving drought indicators to support drought impact mitigation for natural resource management
- Linking indicators of drought hazard to multi-sectoral impacts: an application to California

- Evaluation of drought indicators for improved decision-making in public health and emergency preparedness: reducing drought's burden on health
- Developing drought impact models for the Intermountain West Drought Early Warning System

NOAA CLIMATE PROGRAM OFFICE MAPP PROJECTS

The Climate Program Office's Modeling, Analysis, Predictions and Projections Program (MAPP) Program, in collaboration with NIDIS, kicked off 11 new projects (*see full list here*) funded in FY20 that aim to advance our capability to more integrally characterize and anticipate U.S. droughts in the context of hydroclimatic variability and change, linking this research to practical applications. The competitively-selected projects total $5,688,495.

In order to fully characterize droughts and predict their general evolution and specific stakeholder-relevant thresholds, it is increasingly important that we capture the array of complex interactions which may intervene in U.S. droughts—considering processes across timescales, spatial scales, and disciplines, and linking both natural and human-induced effects. Research is needed to advance our understanding of how climate affects drought processes. In addition, we need to know the relevant processes and feedbacks, and link this understanding to a more integrated characterization of droughts and improved probabilistic predictions from seasons to decades. The 11 new projects will help meet these research and information needs and build new cutting-edge capabilities.

A Drought Task Force composed of the funded investigators from UCLA, NOAA's Earth System Research Laboratories/Physical Sciences Laboratory, Dartmouth University, and the National Center for Atmospheric Research will coordinate the activities of researchers supported through MAPP/NIDIS. Since 2011, past iterations of *NOAA's Drought Task Force* have catalyzed community research aimed at improving national and regional drought capabilities. □

▼ Research is a collaborative, multidisciplinary effort. Credit: Rawpixel.com

DEWS UPDATES

Drought and its impacts vary from region to region. The development and implementation of regional Drought Early Warning Systems (DEWS) allows for responsiveness to particular geographic and hydrologic circumstances, as well as value-added information needs specific to stakeholders in the respective areas.

Pollution from wildfires turned the sky orange in San Francisco, California. September 9, 2020. Credit: hkalkan

Pollution from wildfires turned the sky orange over the San Francisco–Oakland Bay Bridge, California. September 9, 2020. Credit: hkalkan

CALIFORNIA-NEVADA

Drought in California and Nevada is a common occurrence that can last for multiple years.

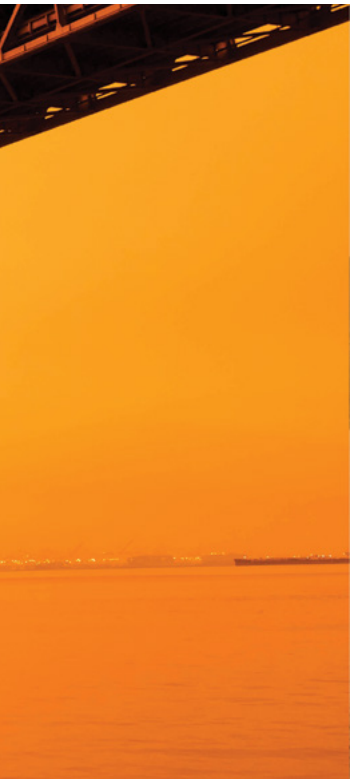
The regional climate is characterized by a distinct dry summer season and wet winter season defined by a few large precipitation events. Topography within the CA-NV region creates a diverse set of climate conditions, from the snowy peaks of the Sierra Nevada Range to the Mojave Desert, to the mountains and valleys of the Basin and Range. Given the extreme variability, both spatially and temporally, efficiently using and effectively managing finite water resources is a high priority.

RISING "ATMOSPHERIC THIRST" TO INCREASE FIRE DANGER AND DROUGHT

Research funded by NIDIS and the California-Nevada Applications Program (CNAP), a NOAA Climate Program Office Regional Integrated Sciences and Assessments (RISA) team, shows that climate change projections point to increases in evaporative demand, fire danger, and drought in California and Nevada. The research, published in *Earth's Future* in 2020, found that days with extreme fire danger in summer and autumn were found to increase 4-10 times by the end of the century. Multi-year droughts are also projected to increase. CNAP, with NIDIS support, continues to engage with fire managers and their use of evaporative demand information across timescales. For example, Predictive Services is now using EDDI in the weekly updated national weather and fuels briefings. The research was led by the Desert Research Institute and Western Regional Climate Center, with co-authors from CNAP and in collaboration with University of California, Merced.

ENHANCING THE RED FLAG WARNING MATRIX

CNAP, NIDIS, and fire personnel have conducted an assessment of the Red Flag Warning (RFW) definition, inputs, usefulness, usability, and impact. This assessment has led to an ongoing project, described in this *fact sheet*, with the NWS to enhance the Red Flag Warning (RFW) matrix, which will be vetted in CA-NV. The final product will be meant to serve fire management, emergency managers, and the public.



The CA-NV DEWS includes all of California and Nevada. Credit: NOAA NIDIS

▲ California-Nevada Drought and Climate Outlook Webinar. Credit: NOAA NIDIS

▲ Post-Wildfire Project: *Drought Influences on Post-Wildfire Flooding and Debris Flow Hazard*. Credit: NOAA NIDIS

DROUGHT INFLUENCES ON POST-WILDFIRE FLOODING AND DEBRIS FLOW HAZARD

While there is a strong connection between drought and wildfire in the western US, how drought influences the post-wildfire environment is less well-understood. Because vegetation recovery depends on weather and climate conditions, drought may play an important role in controlling the likelihood and magnitude of debris-flow hazards during the recovery process. The ultimate goal of this NIDIS-funded project, as described in this *summary document*, is to identify relevant drought and vegetation recovery metrics that can be monitored remotely using data derived from satellites (e.g., Google Climate Engine), to inform how post-fire hazards change with time.

CENTRAL VALLEY WATER USAGE AND CLIMATE VARIABILITY AND LAND USE

CNAP, a NOAA RISA team, in collaboration with USGS and with support by NIDIS, has published research that shows how water diversions throughout California's Central Valley, one of the most productive agricultural regions in the world, are related to climate drivers and land use influence. The research, published in San Francisco Estuary and Watershed Science, shows that an initial estimate of diversions based on climate variables and land-use can be generated years before official data is released and therefore could be used to drive Central Valley groundwater models to estimate pumping.

DROUGHT & CLIMATE OUTLOOK WEBINARS

The California-Nevada DEWS Drought & Climate Outlook webinars were held every other month throughout 2020. These webinars provided the region's stakeholders with timely information on current and developing drought conditions as well as climatic events like the current La Niña. The webinars also discussed the impacts of these conditions on wildfires, floods, water supplies, and ecosystems, as well as impacts to industries like agriculture, tourism, and public health. The webinars were sponsored by NIDIS, CNAP, WRCC, DRI, and Scripps Institution of Oceanography. □

Waterfall near the Havasu Falls Trail in the Havaspai Indian Reservation, Grand Canyon, Arizona. Credit: Patrick Lansing

INTERMOUNTAIN WEST

While all five states in the Intermountain West depend on the over-allocated Colorado River, climatic, geographic, economic, and social conditions vary significantly across the region, which ranges from deserts and riparian woodlands to high valleys and alpine systems.

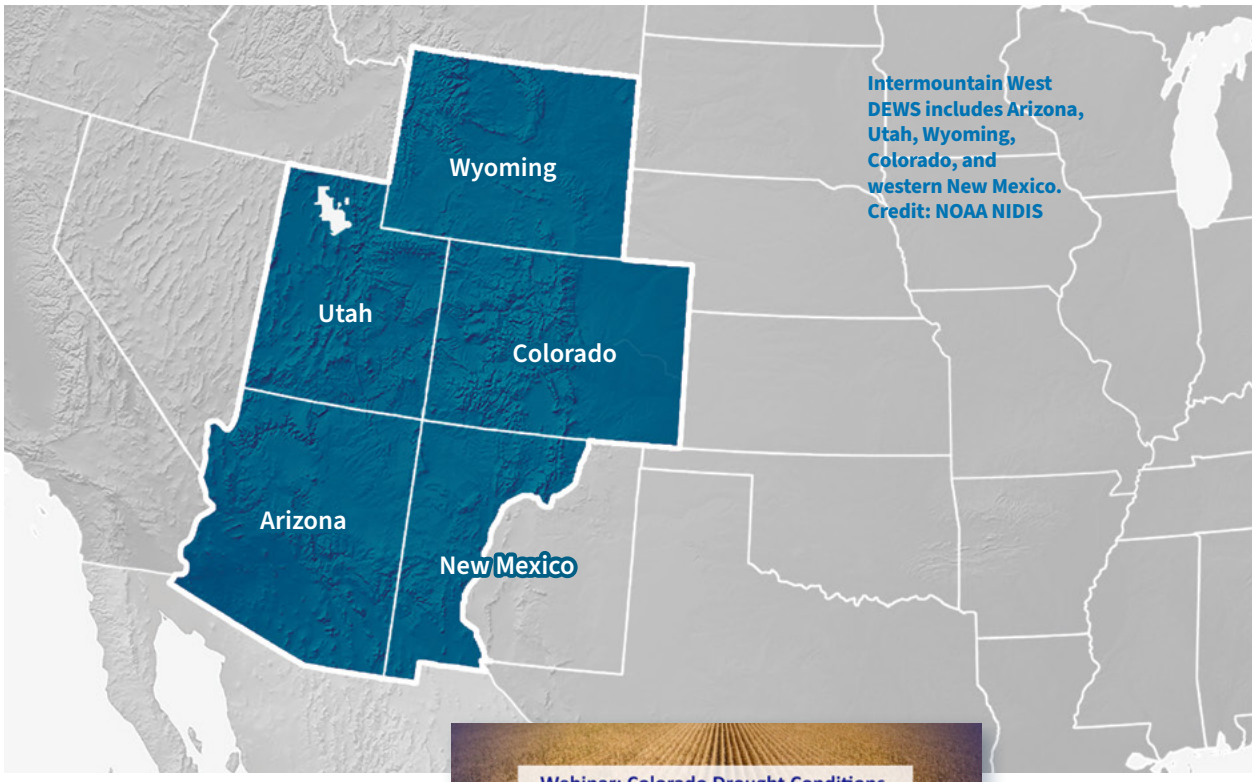
The Southwestern Monsoon is a dominant driver of weather in the Lower Basin states, while continental weather systems have a greater impact in the Upper Basin states. Droughts may onset quickly as a flash drought in portions of Colorado and Wyoming, and may last decades, as with current conditions in parts of Arizona.

SOUTHWEST DROUGHT AND HUMAN HEALTH WORKSHOP

The Southwest Drought and Human Health Workshop, held February 26-27, 2020 at the University of Arizona at Tucson, identified gaps and needs, collaborative opportunities, and ways to integrate the health sector into the Intermountain West DEWS. NIDIS co-hosted the workshop with the University of Nebraska Medical Center, and the University of Arizona Center for Climate Adaptation Science and Solutions. The participants included state and local public health departments, climate scientists, emergency managers, tribal communities, and health-care providers.

STUDY OF DROUGHT INFORMATION FOR LAND DEVELOPMENT

NIDIS partnered with the University of Colorado's Master of the Environment program to research whether and how land use decision makers use drought information in their decision making processes. Ninety-six experts from the industry were interviewed, including 39 water planners, 34 land use planners, 18 industry experts (e.g., advisors, professors, etc.), 13 property developers, and 10 county commissioners. The study concluded that the



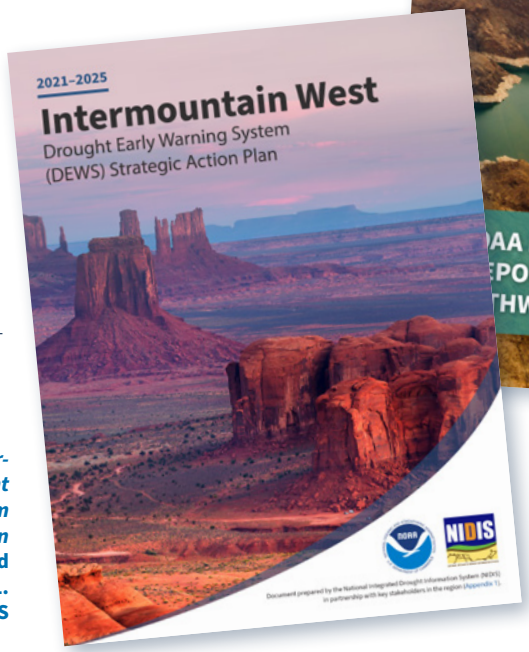
Intermountain West DEWS includes Arizona, Utah, Wyoming, Colorado, and western New Mexico. Credit: NOAA NIDIS

use of drought information varied by state and an individual's role in the development process, but in general, a majority of land use decisions are not made using drought (or other water availability) information.

► Colorado Drought Conditions, Outlook, and Fire Risk webinar. Credit: NOAA NIDIS

RESPONDING TO THE 2020 DROUGHT

With drought developing and intensifying throughout the Intermountain West in 2020, NIDIS co-hosted a number of regional webinars to provide information on current and future weather and climate conditions. These included New Mexico drought webinars with a focus on tribal lands, a Colorado-focused webinar assessing fire risk, and a southwest monsoon recap webinar examining impacts related to the poor monsoon season with a focus on Arizona and New Mexico. The webinars included federal, state, and tribal partners. □



► The *2021–2025 Intermountain West Drought Early Warnin System (DEWS) Strategic Action Plan* was published in October 2021. Credit: NOAA NIDIS

▲ The *NOAA Drought Task Force Report on the 2020–2021 Southwestern U.S. Drought* was published in September 2021. Credit: NOAA NIDIS

Apple crates sit in an orchard, ready to be filled. Credit: Antho B

MIDWEST

Over the last century, precipitation patterns in the Midwest have been trending towards wetter conditions and fewer droughts than the region experienced in the early 20th century. However, the Midwest continues to be challenged by droughts such as those in 1988 and 2012.

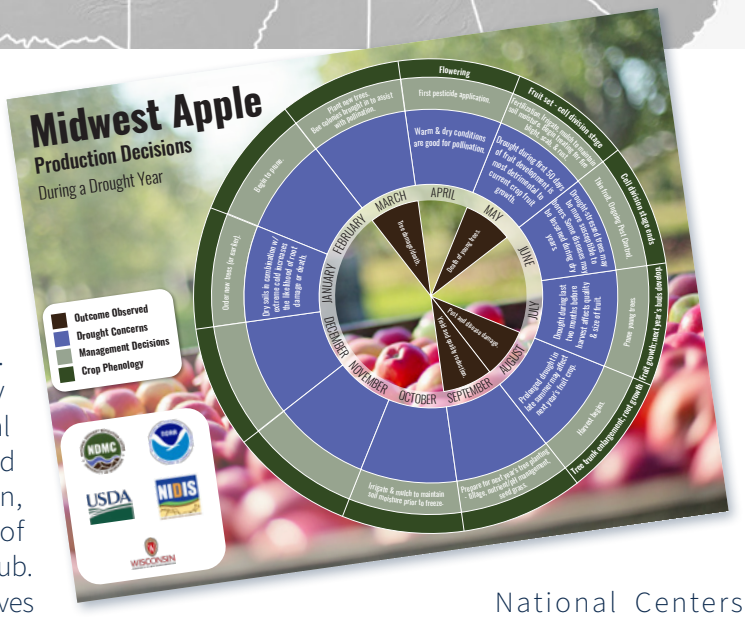
The 2012 drought led to nearly $35 billion in direct losses for the U.S., including closing the Mississippi River at least three times. These adverse impacts include limited barge transportation on major rivers, decreased agricultural production, challenges for municipal water supply and quality, and reduced productivity for hydropower. More recently, water managers have been challenged by rapid transitions from drought to flood and back to drought within short time spans.

TRIBAL DROUGHT ENGAGEMENT STRATEGY FOR THE MISSOURI RIVER BASIN AND MIDWEST

NIDIS released its inaugural *Tribal Drought Engagement Strategy* in 2020, which presents guiding principles of tribal engagement, as well as key outcomes and tribal engagement activities for NIDIS and partners to implement in 2021 and beyond. This Strategy was developed by engaging with tribal nations within the Missouri River Basin and Midwest Drought Early Warning Systems (DEWS) in 2019 through a partnership with the Masters of the Environment Program at University of Colorado-Boulder. This partnership included a year of consultations with tribal resource managers across the two regions, which helped identify critical needs and the actions that could be taken to address them, and led to the development of this Strategy.

SPECIALTY CROP DECISION CALENDARS AND FACT SHEETS

This project developed a set of decision calendars that provide month-by-month and seasonal advice on how growers manage production of Midwestern apple, grape, cranberry, and irrigated potato crops during drought years. The project, "Connecting Drought Early Warning to the Decision Making Needs of Specialty Crop Producers



▲ **Midwest DEWS includes Missouri, Kentucky, Iowa, Illinois, Indiana, Ohio, and southern Minnesota, and western Wisconsin. Credit: NOAA NIDIS**

◄ **Apple Production Decision Calendar from Connecting Drought Early Warning to the Decision-Making Needs of Specialty Crop Producers in the Midwestern U.S.**

in the Midwestern United States," also includes fact sheets highlighting appropriate drought and climate tools for monitoring conditions during the growing seasons and beyond are also available. The project was funded by NIDIS and led by the National Drought Mitigation Center and the University of Wisconsin, with the U.S. Department of Agriculture Midwest Climate Hub. Advisors included representatives from Iowa State University, the Iowa Winegrowers Association, University of Missouri Extension, University of Wisconsin-Madison Extension, Wisconsin Potato and Vegetable Growers Association, and Wisconsin State Cranberry Growers Association.

RESPONDING TO THE 2020 DROUGHT

NIDIS issued four drought status updates in 2020 as conditions worsened and persisted for the North Central region, including the Midwest and Missouri River Basin. These updates were issued in partnership with NOAA's National Centers for Environmental Information, National Weather Service, High Plains Regional Climate Center, and Midwestern Regional Climate Center. □

▲ **Cattle drinking hole in a prairie of Nebraska Sandhills. Credit: Marek Uliasz**

MISSOURI RIVER BASIN

Drought is a frequently occurring natural hazard in the Missouri River Basin (MRB). Significant drought events occurred in the 1930s and 1950s that substantially affected water supplies, crops and livestock, energy, transportation of goods, and the ecosystem.

In 2012, a large-scale drought event occurred. It was unique in that it followed a devastating flood across the MRB in 2011. The Upper Missouri River Basin was hit again in 2017 with a flash drought that led to agricultural losses alone totaling more than $2.6 billion dollars.

MISSOURI RIVER BASIN DEWS STRATEGIC PLAN

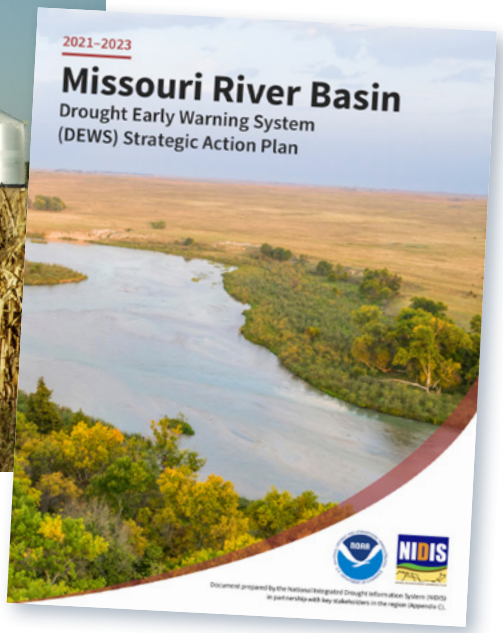
NIDIS and partners from across the MRB met in Billings, MT, in 2019 to update the existing MRB Strategic Plan. Four priorities and a series of outcomes and actions organized by the five components of a DEWS were identified to be part of the next iteration of a MRB Strategic Action Plan (SAP). The plan, issued in 2020, contains activities that the MRB DEWS network will initially focus on, organized by components of a drought early warning system. Annual meetings will be used to reassess priorities and direct action within the DEWS during the life of the plan.

TRIBAL DROUGHT ENGAGEMENT STRATEGY FOR THE MISSOURI RIVER BASIN AND MIDWEST

In order to ensure the inclusion of indigenous perspectives in the implementation of our DEWS, NIDIS launched a Tribal Drought Engagement initiative in January 2019 in collaboration with the Masters of the Environment Program at University of Colorado-Boulder. The project aimed to strengthen relationships with tribal resource managers across the Missouri River Basin and Midwest DEWS regions in order to effectively deliver timely and relevant drought information. The *NIDIS Tribal Drought Engagement Strategy: 2021–2025*, published in 2020, included a year of consultations with tribal resource managers across the two regions. These consultations

The MRB DEWS includes Nebraska and parts of Montana, Wyoming, Colorado, Kansas, Missouri, Iowa, Minnesota, North Dakota, and South Dakota. Credit: NOAA NIDIS

An ethanol production plant in South Dakota. Credit: Jim Parkin



▼ MRB Strategic Plan: *2021-2023 Missouri River Basin Drought Early Warning System Strategic Action Plan*. Credit: NOAA NIDIS

helped identify critical engagement gaps and the actions that could be taken to address them.

RESPONDING TO THE 2020 DROUGHT

NIDIS issued four drought status updates in 2020 for the North Central region, including the Midwest and Missouri River Basin. These updates were issued in partnership with NOAA's National Centers for Environmental Information, National Weather Service, High Plains Regional Climate Center, and Midwestern Regional Climate Center. □

Birch and maple trees in autumn. Greylock State Reservation, Massachusetts. Credit: Joseph Sohm

NORTHEAST

Known best for the autumn foliage, thick forests, rocky soils, and abundant freshwater resources, the northeastern United States is characterized by a diverse climate that is not often associated with drought. However, in 2016, New York and New England experienced historic drought conditions not seen since the 1960s.

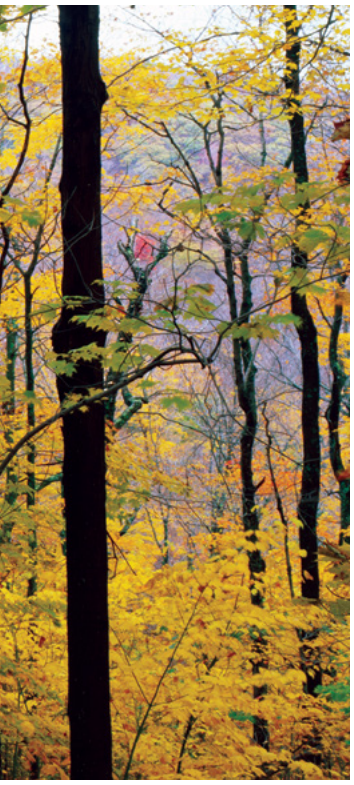
The Northeast also frequently experiences flash droughts that may last only 2–6 months, but can have profound negative impacts on the region.

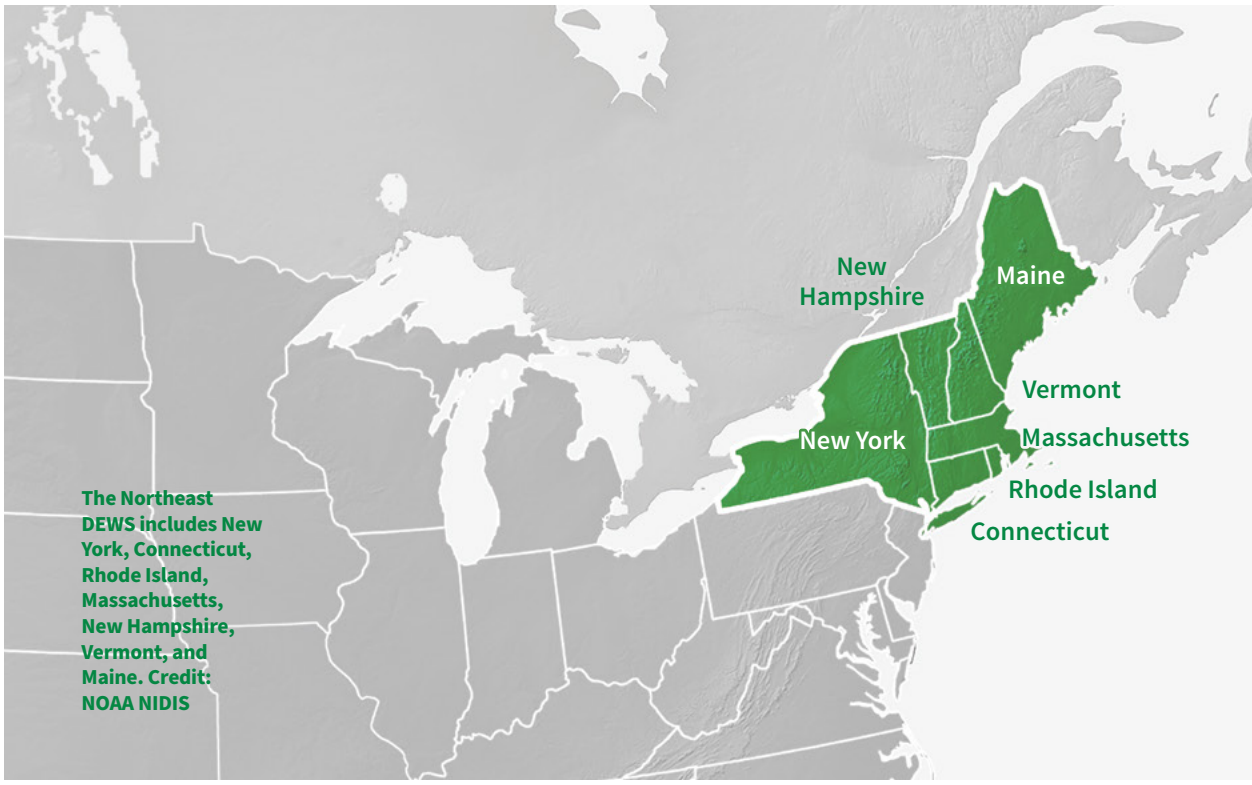
STRATEGIC ACTION PLAN DEVELOPMENT

Listening sessions with key stakeholders and partners were conducted in October and November of 2020 to provide the foundation for an updated Northeast DEWS Strategic Action Plan (2021-2024). Listening session participants included NOAA's Eastern Region Climate Services Director, Northeast Regional Climate Center, USDA, USGS New England Water Science Center, state drought mitigation committee representatives, state climatologists, National Weather Service forecast offices, local emergency management directors, and several Tribal nation representatives. Discussions were centered around (1) Monitoring and Prediction, (2) Water Resource Management, (3) Agriculture, (4) Forestry and Ecosystems, with (5) Communications, Awareness, and Education emerging as a cross cutting theme. The plan will be finalized in 2021.

WATER SECTOR SUPPORT

The Northeast Regional Climate Center hosted a workshop, partially funded by NIDIS, for small to medium sized water management utilities in July of 2020. Over 100 attendees reviewed drought history in New England, received an overview of tools available on the NE DEWS dashboard, and a demonstration of key elements of the US Drought Monitor. There was also a breakout session





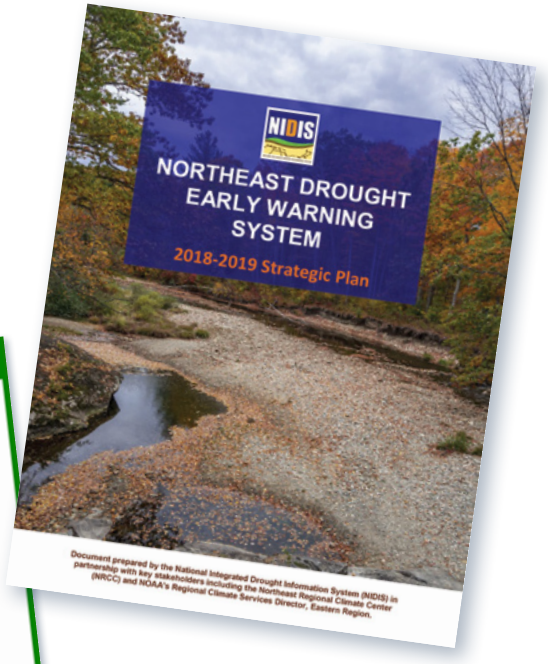
The Northeast DEWS includes New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine. Credit: NOAA NIDIS

for hands-on practice with the EPA's drought response and recovery guide.

RESPONDING TO THE 2020 DROUGHT

NIDIS and partners issued 25 updates in 2020 addressing drought in the Northeast DEWS region. The Drought Early Warning Updates were issued in partnership with the Northeast Regional Climate Center, the National Centers for Environmental Information, USDA Climate Hubs, and the USGS/New England Water Science Center. Throughout the 2020 drought, the Northeast DEWS also supported state drought mitigation committees with weekly temperature and precipitation updates, outlooks, and impact summaries. □

▼ Northeast DEWS 2018–2019 Strategic Plan. Credit: NOAA NIDIS



► Drought Early Warning Update for the Northeast. Credit: NOAA NIDIS

PACIFIC NORTHWEST

The Pacific Northwest (PNW) is often associated with rainy forecasts, foggy days on the coast, and large scale irrigated agricultural projects in the arid interior. It is an ecologically diverse region heavily reliant on snowpack, precipitation, groundwater, and highly managed rivers for its water supply.

Sunset in Mount Rainier National Park, Washington. Credit: Checubus

▲ PNW Drought and Climate Outlook Webinar. Credit: NOAA NIDIS

Despite its soggy reputation, the region experienced multiple droughts in the early 21st century. In 2015, virtually the entire region reached historic drought conditions. While the coastal regions experienced an unprecedented single-year drought, the eastern portions of Oregon and Idaho had been suffering under prolonged drought for four years.

PACIFIC NORTHWEST DEWS STRATEGIC PLAN

The Pacific Northwest Drought Early Warning System (DEWS) Strategic Plan, issued in 2020, outlines priority tasks and activities to build drought early warning capacity and resilience. Partners from across the PNW met in Portland, OR in October 2019 to discuss progress made since the 2017-2018 strategic plan and next steps. Discussions acknowledged the progress made to better communicate and collaborate in preparing for and responding to drought, and led participants to ask how the DEWS might further facilitate not only information delivery but also action to reduce the impacts of drought.

WATER YEAR MEETINGS AND WATER YEAR IMPACT ASSESSMENT IN THE NORTHWEST

The Oregon-Washington Water Year Meeting was held from October 28-29, 2020 as a virtual meeting. The meeting included a recap of the 2020 water year with a focus on extremes—winter flooding to drought and wildfire, key events and impacts in Oregon and Washington, the outlook for water year 2021, as well as new resources and information that can be used to plan and prepare for the future climate and climate-related events. The virtual meeting was hosted by NIDIS, the University of Washington Climate Impacts Group, and the Office of the Washington State Climatologist. Planning committee members included the Oregon Climate Service, Oregon State University's Climate Impacts and Research Consortium, the Oregon Water Resources Department, the WA Department of Ecology, and USDA Northwest Climate Hub and Natural Resources Conservation Service.

The annual Idaho Fall Water Supply Outlook meeting was held virtually from November 5-6 to recap the water supply from the previous water year and provide climate and water supply outlook information for the coming water year. The meetings identified vulnerabilities and opportunities for increasing drought and climate resilience in the agricultural, power, and recreational sectors of Idaho's economy that are dependent on the state's water resources. This event was sponsored and supported by NIDIS, NWS, the Idaho Department of Water Resources, Idaho Power Company, Army Corps of Engineers, United States Bureau of Reclamation, and the Natural Resource Conservation Service's Snow Survey program.

◄ (*Top*) 2020 Pacific Northwest Water Year Impacts Assessment. (*Bottom*) PNW Strategic Plan. Credit: NOAA NIDIS

▲ The Pacific Northwest DEWS includes Idaho, Oregon, Washington, and part of Canada. Credit: NOAA NIDIS

For the first time in 2020, a Pacific Northwest (PNW) regional survey to collect water year impacts for multiple sectors was developed in addition to these discussions. This information was then used to generate the *2020 Pacific Northwest Water Year Impacts Assessment*, which summarizes the water year conditions and sector impacts as a resource for future management of drought and other climate extremes. This effort was supported by NIDIS and authored by the Office of the Washington State Climatologist, UW Climate Impacts Group, Oregon State Climatologist, Idaho Department of Water Resources with assistance from the partners listed above.

RESPONDING TO THE 2020 DROUGHT

A priority of NIDIS is to coordinate regional and interstate communication during drought events. As drought evolved in the Pacific Northwest in 2020, NIDIS convened state partners virtually from mid-May to December to discuss conditions, compare notes on impacts, provide input to the U.S. Drought Monitor, develop plans to collect information in data poor areas, and gather adaptation strategies that were observed for different sectors. The meetings included NIDIS, the Oregon, Washington and Idaho State Climate Offices, the Oregon Department of Water Resources, the Washington Department of Ecology, the ID Department of Water Resources, the Oregon Climate Change Research Institute, and the USDA Natural Resources Conservation Service and Northwest Climate Hub. Staff from Senator Merkley's Office took part when the discussion focused on drought impacts in Oregon. The partners felt these meetings were valuable and should continue even when the region is not in drought.

DROUGHT AND CLIMATE WEBINARS

Pacific Northwest DEWS Drought & Climate Outlook Webinars were held every other month throughout 2020. These webinars provided the region's stakeholders with timely information on current and developing drought conditions, as well as climatic events like El Niño and La Niña. The webinars also discussed the impacts of these conditions on wildfires, water supplies, ecosystems, and high precipitation events as well as impacts to sectors like agriculture, tourism, and public health. Webinars were sponsored by NIDIS, the Climate Impacts Research Consortium (CIRC), USDA Northwest Climate Hub, and the NWS, Western Region. □

Dwarf cypress trees in extreme drought conditions. Everglades National Park, Florida. Credit: Francisco Blanco

▼ Southeast Monthly Climate Webinar from October 13, 2020

SOUTHEAST

The Southeast region generally receives substantial precipitation and is often considered water rich. However, the region is increasingly experiencing record-breaking droughts, highlighting competing water demands.

Drought conditions can develop rapidly in the Southeast, especially when the lack of rain and high temperatures combine to increase evapotranspiration of water in the soils.

EXPANDING THE SOUTHEAST DROUGHT EARLY WARNING SYSTEM

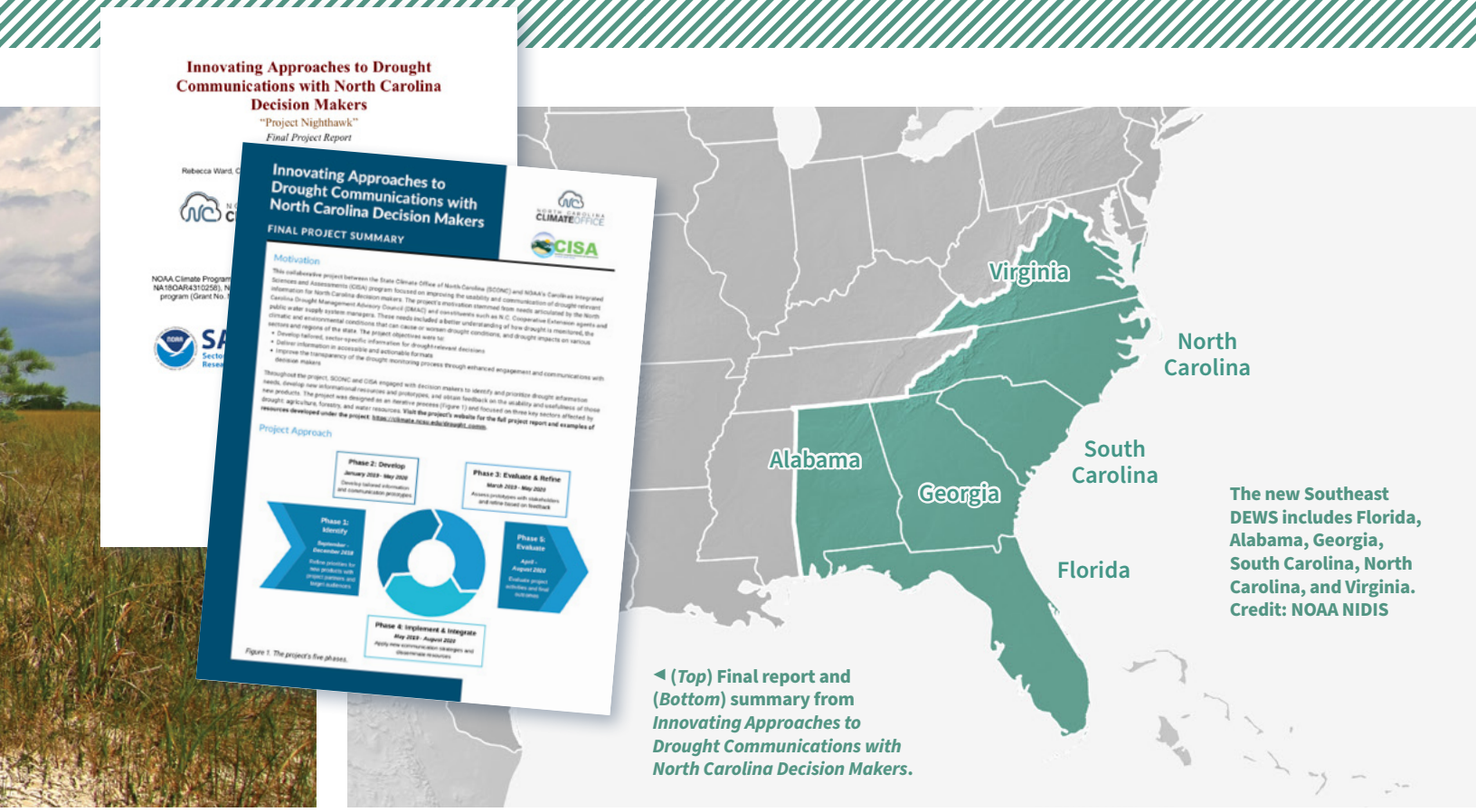
NIDIS launched a newly expanded Southeast DEWS in 2020 to include the full geographic footprint of Florida, Alabama, Georgia, South Carolina, North Carolina and Virginia. The new Southeast DEWS incorporates the Apalachicola-Chattahoochee-Flint (ACF) River Basin DEW and the Coastal Carolinas DEWS.

COMMUNICATING DROUGHT TO DECISION MAKERS

This project developed recommendations to better communicate drought to decision makers as well as resources such as infographics and factsheets that are usable for target sectors like agriculture, forestry, and water resources. The project, *Innovating Approaches to Drought Communications with North Carolina Decision Makers*, was led by the State Climate Office of North Carolina and the Carolinas Integrated Sciences and Assessments (a CPO RISA team) and funded by NIDIS through CPO's Sectoral Applications Research Program (SARP) Coping with Drought Initiative.

CLIMATE AND ACF MONTHLY WEBINARS

NIDIS, Southeast Regional Climate Center (SERCC), NOAA, and NWS launched the Southeast Climate Monthly Webinar series in March 2020. These webinars provide information on current and developing climate conditions such as drought, floods, and tropical storms, as



The new Southeast DEWS includes Florida, Alabama, Georgia, South Carolina, North Carolina, and Virginia. Credit: NOAA NIDIS

◄ (*Top*) Final report and (*Bottom*) summary from *Innovating Approaches to Drought Communications with North Carolina Decision Makers*.

well as climatic events like El Niño. Speakers also discuss the impacts of these conditions on topics such as wildfires, agriculture production, disruption to water supply, and ecosystems. The Apalachicola-Chattahoochee-Flint (ACF) Drought and Water monthly webinar series began ten years ago and also provides the region's stakeholders with timely information on current and developing drought and flood conditions. They are led by the Auburn University Water Resources Center with support from NIDIS.

DROUGHT UPDATES FOR PUERTO RICO AND THE U.S. VIRGIN ISLANDS

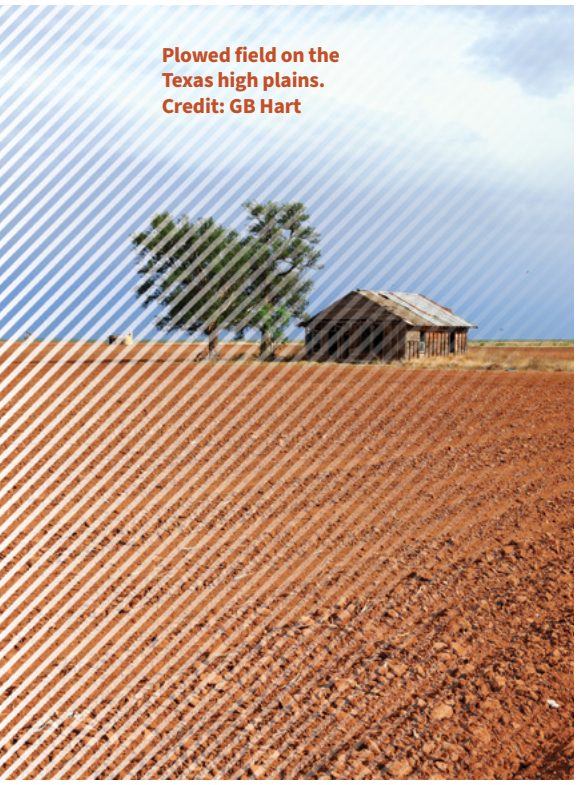
Drought Updates for Puerto Rico and the U.S. Virgin Islands were issued for the first time in 2020, in a partnership between NIDIS, NWS, USDA, and the University of the Virgin Islands. The updates are issued in English and Spanish. The purpose of the updates are to communicate a potential area of concern for drought expansion and/or development within Puerto Rico and the U.S. Virgin Islands based on recent conditions and the upcoming three month forecast. NIDIS and its partners will issue these updates every two months.

ACF DROUGHT DASHBOARD

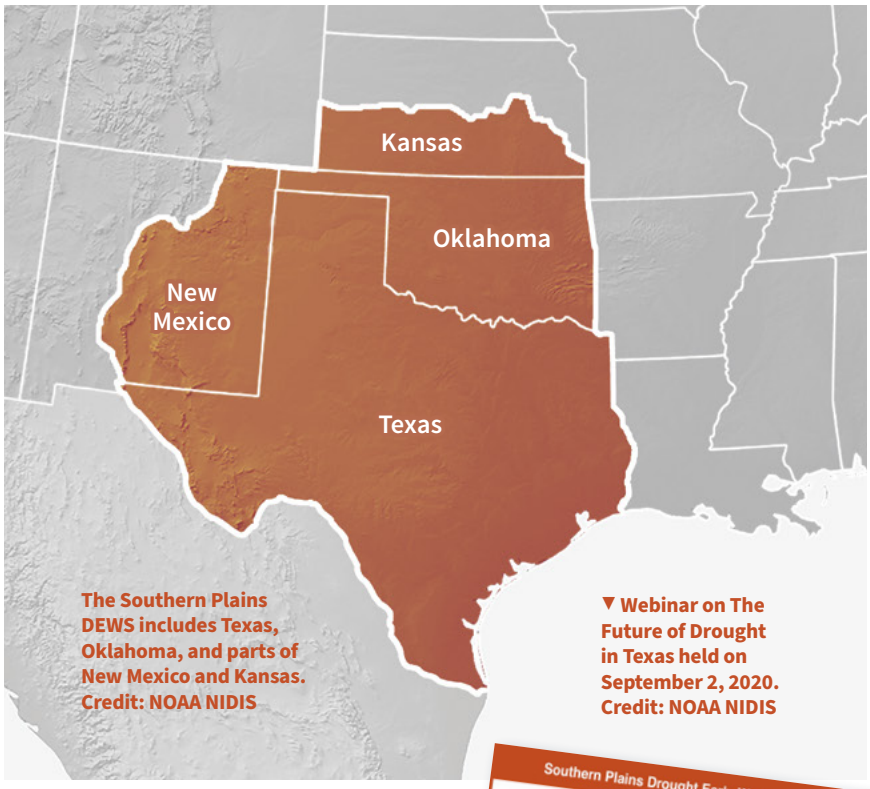
NIDIS is supporting the development of a new ACF Drought Dashboard that will be located on drought.gov. This will be a free, web-based GIS application that allows users to monitor drought situations in real-time and facilitate data-driven decision making. Four stakeholder listening sessions to inform the development of the ACF Drought Dashboard were held in early 2020. This effort is being led by NIDIS, NESDIS/NCEI, Albany State University, and Auburn University. The final Dashboard will be launched in 2021.

CAROLINAS DROUGHT AND HUMAN HEALTH VIRTUAL WORKSHOP

On Sept 23-24, 2020, the University of Nebraska Medical Center (UNMC) and NIDIS hosted a Carolinas Drought and Human Health Virtual Workshop, focused on sharing regional drought-related human health impacts, current research and activities, and identifying gaps, needs, and collaborative opportunities. This workshop is one of a series of regional workshops hosted by NIDIS and UNMC. Outcomes will additionally help identifying priorities for a national NIDIS drought and human health strategy. □



Plowed field on the Texas high plains. Credit: GB Hart



The Southern Plains DEWS includes Texas, Oklahoma, and parts of New Mexico and Kansas. Credit: NOAA NIDIS

▼ Webinar on The Future of Drought in Texas held on September 2, 2020. Credit: NOAA NIDIS

SOUTHERN PLAINS

The Southern Plains DEWS contains diverse climates such as the semi-arid region of the Texas and Oklahoma panhandles and western Kansas, desert in eastern New Mexico and Big Bend Country of western Texas, and the hot, humid subtropical Gulf Coast.

With high rainfall variability from year-to-year, drought is a natural part of the climate pattern across the Southern Plains. Historically, droughts have been accompanied by heatwaves and dust storms. While droughts can occur during any time of the year, those that coincide with crop cycles can be especially costly. The Southern Plains can also experience extreme and sometimes hazardous weather including strong winds, hurricanes that cross the Gulf Coast, and severe thunderstorms that can sometimes produce tornadoes.

RESPONDING TO THE 2020 DROUGHT

NIDIS and partners issued five updates and held three webinars in 2020 addressing drought in South Texas and the Southern Plains DEWS region. The updates were issued in partnership with the USDA and the offices of the state climatologists for Colorado, Kansas, New Mexico, Oklahoma, and Texas and Texas AgriLife Extension at Texas A&M University. Additionally, NIDIS hosted a webinar in 2020 with the Texas State Climatologist discussing the future of drought in Texas, including drought projections, related climate factors, and some barriers to the use of these projections by Texas agricultural producers, large surface water suppliers, small groundwater management districts, and regional water planning districts. □

NIDIS PARTNERS

NIDIS partners with dozens of agencies across the federal government:

U.S. Department of Agriculture (USDA)
- Agricultural Research Service
  - Climate Hubs (NIDIS Executive Council Member)
- Cooperative State Research, Education, & Extension
- Farm Service Agency
- Forest Service
- National Agricultural Statistics Service
- Natural Resources Conservation Service
  Risk Management Agency

U.S. Department of Commerce (DoC)
- International Trade Administration
- National Oceanic & Atmospheric Administration

U.S. Department of Energy (DoE)
- Office of Electricity Delivery & Energy Reliability
- Office of Energy Efficiency & Renewable Energy
- Office of Science

U.S. Department of Homeland Security (DHS)
- Federal Emergency Management Agency (FEMA)

U.S. Department of the Interior (DoI)
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- National Park Service
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

U.S. Department of Transportation (DoT)
- Federal Aviation Administration
- Federal Highway Administration
- Surface Transportation Board

Army Corps of Engineers

Environmental Protection Agency (EPA)

Farm Credit Administration (FCA)

National Aeronautics & Space Administration (NASA)

National Science Foundation (NSF)

Small Business Administration (SBA)

U.S. Department of Health And Human Services (HHS)

Centers For Disease Control & Prevention (CDC)

Additionally, NIDIS partners with hundreds of national, tribal, state, and local governments and agencies, plus academia, nonprofit organizations, and the private sector.

www.drought.gov

Have questions about the report? Please contact:
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